



WATER TECHNOLOGY FARM REPORT

HOMELAND FARM 2019

2019 HARVEST DATA INFORMATION

HOMELAND WATER TECHNOLOGY FARM

2019 Growing Season Testimonial of overall tech farm experience this season:

This was our first year in the Water Technology Farm program and because of that we worked hard to get everything setup and enrolled in the program. We have four fields in the program with each representing different types of fields we farm and believe that each will help other farmers to look at our testing and see a field that might be similar to one they have. The fields involve a section sprinkler and three quarter-section sprinklers that have a variety of soils including Richfield Silt Loam, Goshen, Ulysses, and Colby Silt Loam, a large variance between them in soil and sprinkler type additionally two of the pivots are wiper style while the other two are irrigated traditionally.

We are using six different technologies or management practices across the four fields. The most unique is using cover crops as a part of our rotation to control weeds, build water infiltration, and increase the water holding capacity of our top soil. The other five technologies we are using are more traditional when you think of technology such as soil moisture probes, mobile drip irrigation (Dragon Line), variable rate irrigation with variable rate planting, and Aerial or Satellite imagery.

The field with the section sprinkler is split into a north and south half and is irrigated in a wiper-style utilizing two small wells. There was wheat on the north half but didn't do any kind of technology on that half because of just entering the water tech program. However, we did try a small 10-acre cover crop test plot after we harvested the wheat. We could not plant the whole field because it was being enrolled into the Conservation Stewardship Program [CSP] to cover part of our funding on cover crops. We were surprised at how well the plot did in spite of not being planted until July 22 because of a very late wheat harvest and then turning dry after it was planted. The cover crop did an adequate job of controlling pig weeds along with various others and it increased the biomass substantially which will help build our organic matter in the soil in the future. (You can see pictures of the over crop later in the report.)

The first soil moisture probe we used was the Phytech system which utilizes plant sensors to continuously measure stalk diameter along with a 12-inch soil moisture probe that uses algorithms to quantify and predict water stress. Last year the Phytech system did a good job of predicting water stress on the field we used it on however this year with getting a lot of moisture early in the growing season our crop scout had a harder time using it to predict plant water stress with at times it seemed to give a false reading. After talking with Phytech and clarifying some things we are looking forward to testing it again in 2020 to see how it works. The other soil moisture probe we used was the AquaSpy probe that showed general trends in soil moisture over a four-foot deep probe area. AquaSpy (as does Phytech) uses an app that shows general moisture trends compared to current root growth and current moisture availability every four inches. Our crop scout really liked this probe and believe it tied in with a weather station with good long-range forecasts for the area, seeing it would be a must have. The AquaSpy is one we believe works but again needs further usage to verify what we saw after one year.

Mobile drip irrigation definitely helped decrease over-watering in the first four sections of our section sprinkler whereas in past years you would see a big bullseye on irrigation imagery showing a lot of overwatering. We also did not see plant climbing, green snap, or ear snap in our usage this year of Dragon Lines but want to continue to see if it holds true in upcoming years. We believe this may be helped because of planting in a circle around the pivot rather than straight rows across the circle.

Variable rate planting and irrigation [VRI] will need further usage to determine its usefulness because we did not get the VRI turned on until later in the season.

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The last technology we worked with was Aerial Imagery and this was one our crop scout and Ray both used throughout the season to look at overall field water stress and health. We believe that satellite imagery might be comparable to the aerial imagery we used (Ceres) but would need to be able to compare them. This technology gives a good weekly view of the fields and it verified what our crop scout was seeing in various in-field observations.

As far as looking ahead, our focus in 2020 will be working with cover crops in our crop rotation whether it is aerial planting or relay planting with a planter to build our soil health and see if we can increase the water storage capacity of our soil. Second, will be to continue to test soil probes comparing both Phytech and AquaSpy technologies. Third, will be continuing to monitor the Dragon Line and how it works in the second year of use. Fourth, we want to continue to work with VR planting and irrigation and with that tie in weather stations on those fields to better plan for future moisture events. We went to the Winter Water Tech Expo on January 9 to check out other technologies as well.

Information on each Tech Farm Field:

Hoffman Section 13 Sprinkler:

- 1) Crop Types: N2 – Wheat on Corn (2018) / S2 – Corn Silage on Milo (2018)
- 2) Primary use of that crop:
 - a. The wheat was grown for grain.
 - b. The corn was chopped for silage for the J7 Dairy.
- 3) Technology/services utilized
 - a. Aerial Imagery
 - b. Phytech & AquaSpy soil moisture probes
 - c. MIDI (Dragon Line) use on the first 4 sections.
 - d. Planted a 10-acre test plot of a cover crop mix after wheat
 - e. Crop Scout
- 4) Pivot Nozzle Type(s) (if applicable): (Nothing new other than dragon line.)
- 5) Farming Practices this season: No-Till with Herbicides used for weed control. Synthetic fertilizer was used on the corn along with composted manure. No fertilizer was applied to the wheat.
- 6) Cover Crop used? Test plot with an 8-specie mix of: soybeans, milo, sunflowers, pearl millet, Sunn Hemp, Daikon Radish, Buckwheat, & Cowpea
- 7) Yield/Bushel Data:
 - a. Corn Silage Yield Data – 31.37 tons/acre AsFed @ Fixed Dm%
 - b. Wheat yield data below in table:

Field #	Field Name	Acres	Net Bushel	Bushels / Acre	Protein	Test Wt.	Variety	Planting Date	Seeded Lb/A	Yld Goz	N/Ac Appli	Available N	Avg P	Avg S	Avg Zn	Previous Crop
53.1	Hoffman 13 NW irr	123.15	7,769.13	63.09	9.81	58.79	Tatanka	10/3/2018	55.0	85	0	49	38	5	7.40	Flw 18
53.2	Hoffman 13 NE irr	123.15	12,148.75	98.65	10.86	61.86	Tatanka	9/26/2018	55.0	85	0	115	26	5	2.80	Corn 18 irr

- 8) Water use/applied for particular Crop:
 - a. Corn on S2: 8.4 inches applied on Avg. (Flowmeter & AgSense)
 - b. Wheat on N2: 0.4 inches applied on Avg. (Flowmeter & AgSense)
- 9) Water use for entire calendar year:
 - a. Corn on S2: 56,060,357 gallons (Flowmeter & AgSense)
 - b. Wheat on N2: 2,620,043 gallons (Flowmeter & AgSense)

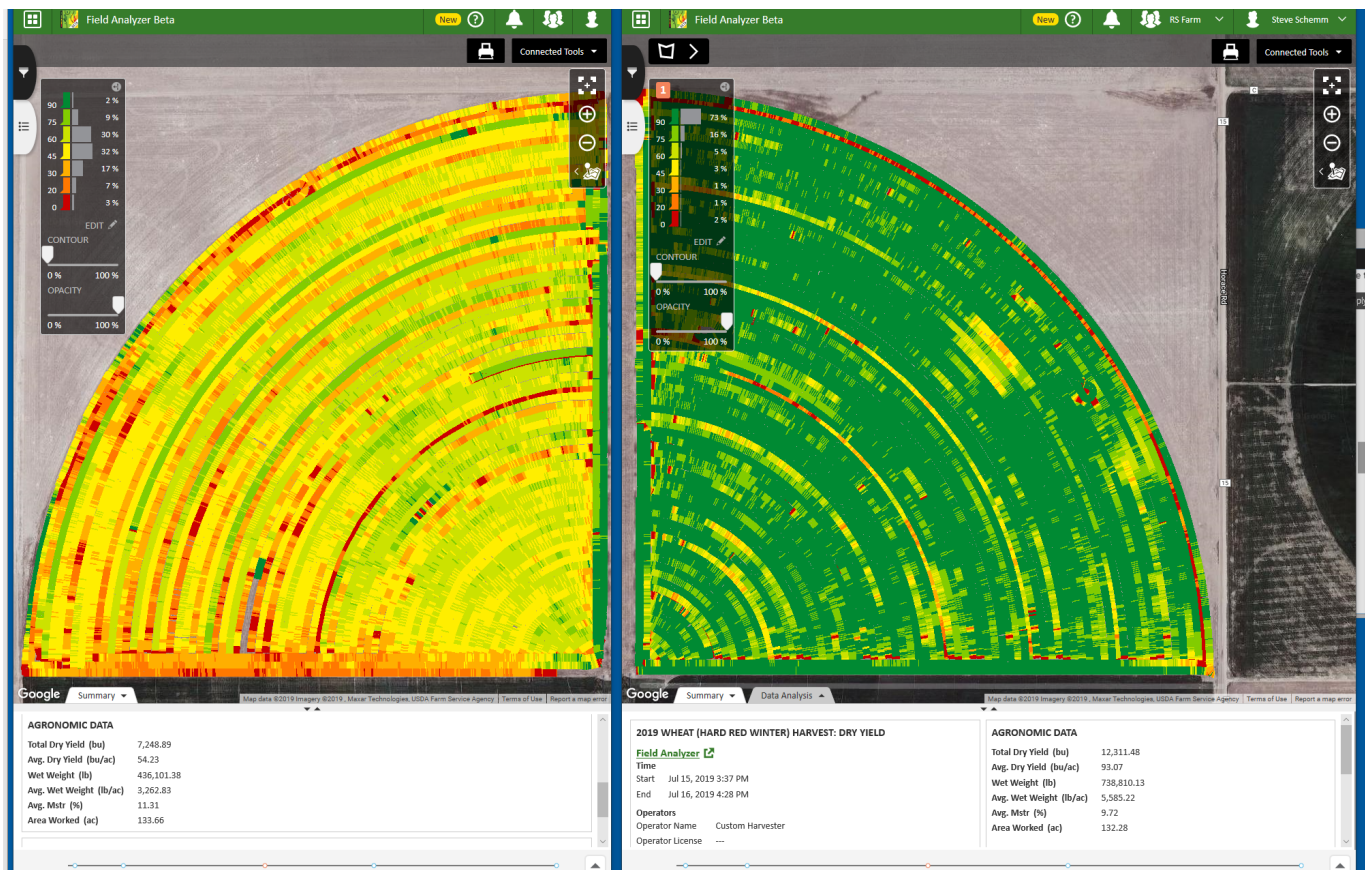
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10) Precipitation data on particular field: 19.01 inches / 1 % drier than Avg.; 3,681 GDD / 4.6% colder.
(FarmLogs)

Additional Documents to include:

- 1) Combine harvest maps - There were no harvest maps for the corn because it was harvested for silage.
Below are the harvest yield maps for the north half of section 13 that was in wheat:



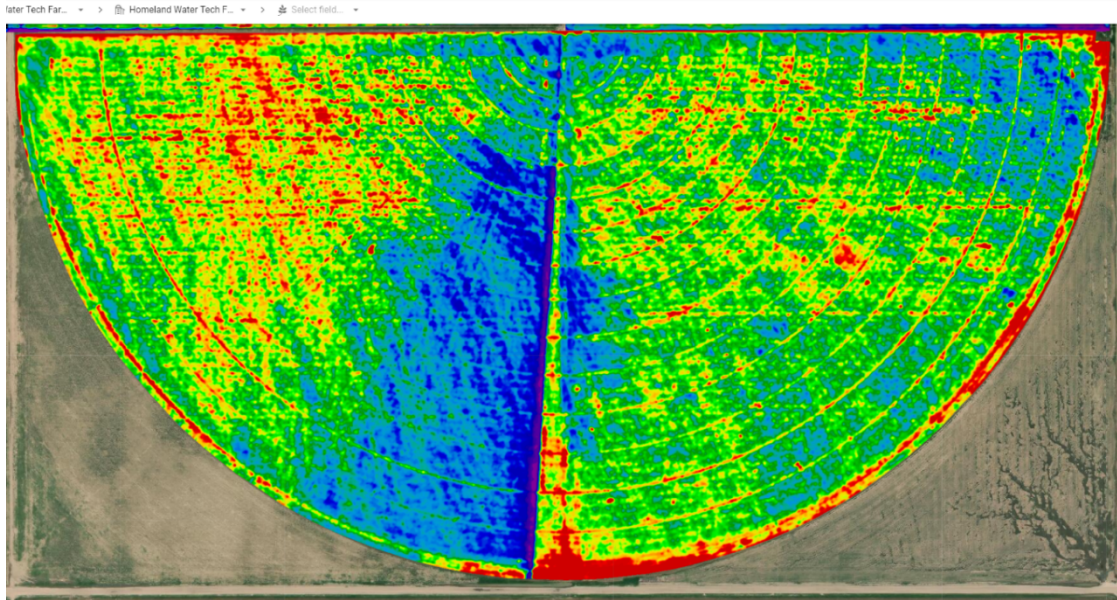
53.1 Hoffman Sec 13 NW 2019 Yld Map (Wheat)

53.2 Hoffman Sec 13 NE 2019 Yld Map (Wheat)

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- 2) Ceres aerial water stress image from 8/7/19 shows crop stress immediately after having just watered (also saw this in 7/12 images and others as well) so we knew it wasn't water stress and looked for other reasons and found a phos & nitrogen deficiency especially in SW quarter after looking at soil tests.



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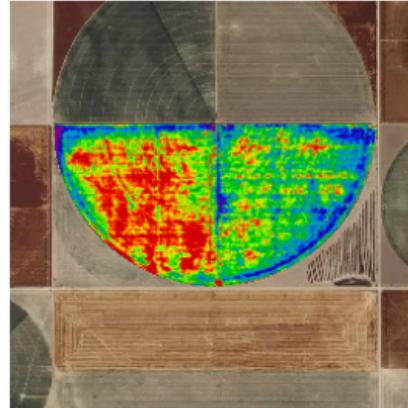
Customer: Kansas Water Tech Farms
Farm: Homeland Water Tech Farm
Field: Hoff 13 S

Crop: Corn
Flight: 2019 - #1
Flight Date: 7/12/2019

RGB

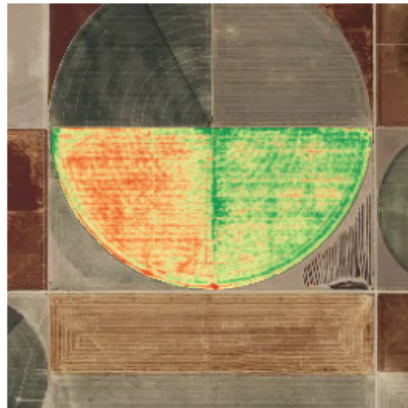


Water Stress

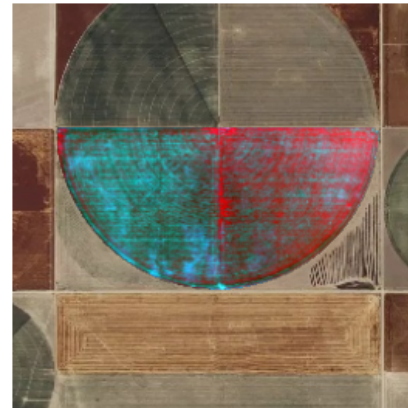


3) Soil Probe monitoring: AquaSpy Soil Probe Pages for Summary & Moisture are below:

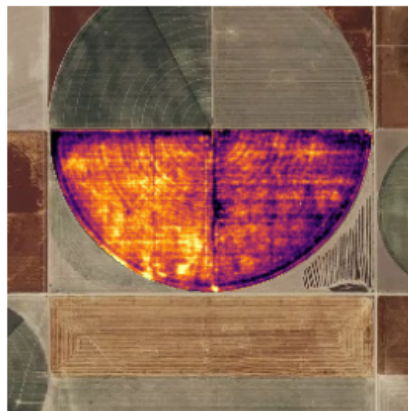
Chlorophyll Index



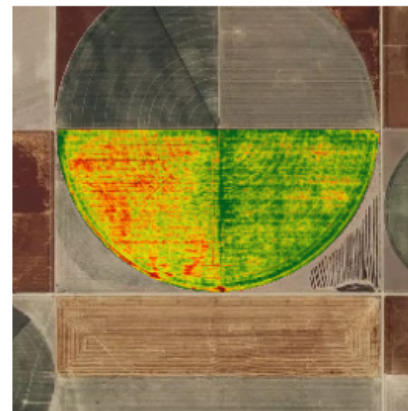
CIR



Core Thermal

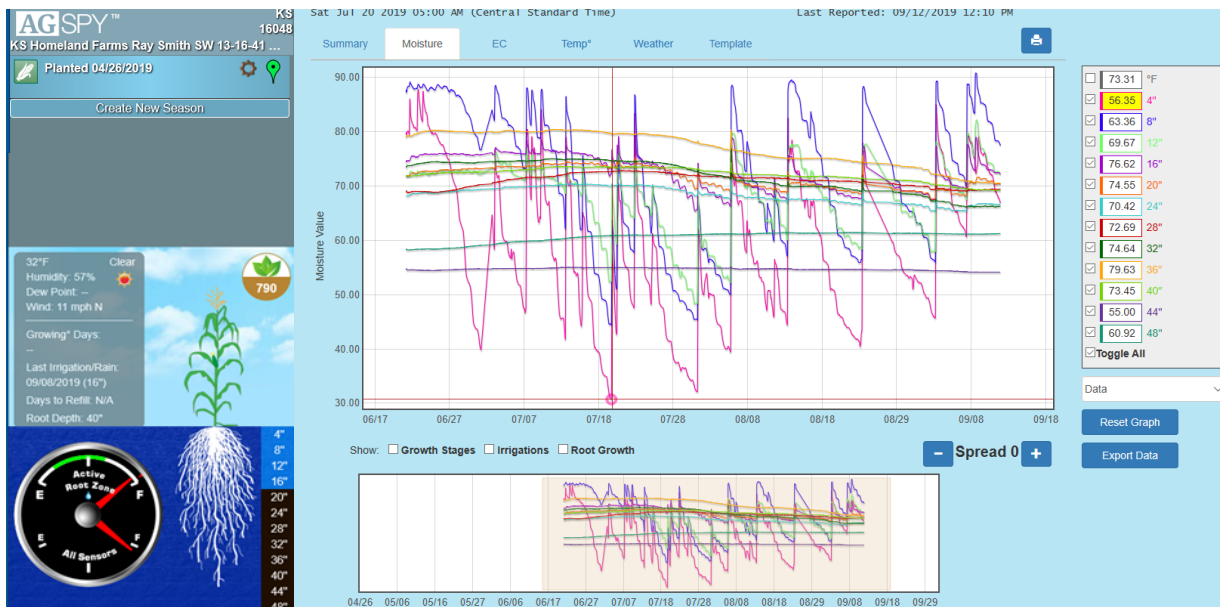
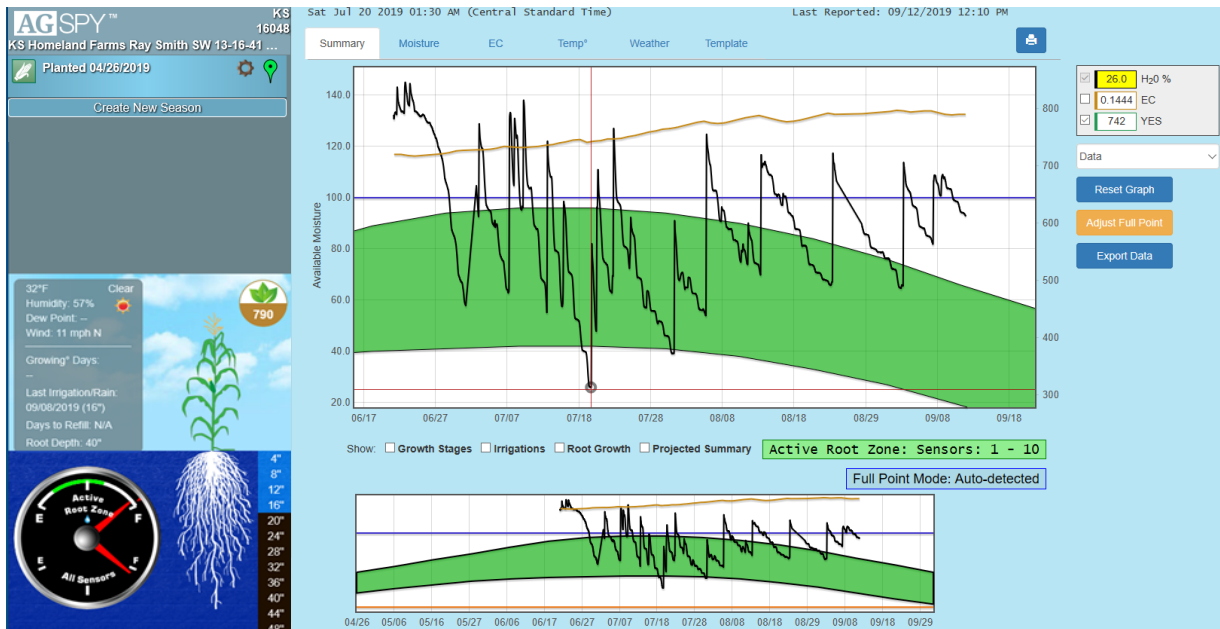


NDVI



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- You can highlight what the moisture % is at any time along with the YES score (general plant health score which is obtained through input from probe sensors which algorithms then analyze).
- The summary page shows the general root zone in the graph along with actual root growth which is shown to the left of the plant image. To the right of the plant roots is a depth gauge showing how deep the last moisture event reached. During the stress period around 7/18 the moisture values dropped significantly in the 4- to 8-inch zones but was still adequate or high in deeper zones, monitoring root growth was important during this period.
- AquaSpy probes are placed in the plant row next to plants so they can measure not only moisture but detect root depth and plant EC.

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4) Soil test results from agronomist in table summary: (An actual soil test result is shown below the table.)

Field #	Field Name	Crop / Year	PH	Org Material	N 0-10 inches lbs./Ac	N 10-24 inches lbs./Ac	P	S	Zn	Date
53.1	Hoffman 13 NW irr	Wht 19 irr	7.7	1.6	6	3	20	10	2.1	Oct-18
53.2	Hoffman 13 NE irr	Wht 19 irr	7.8	1.9	7	14	41	11	1.8	Oct-18
53.4	Hoffman 13 SE irr	Corn 19 irr silage	7.7	2.3	13	5	46	10	2.9	Nov-18
53.4	Hoffman 13 SW irr	Corn 19 irr silage	7.6	2.1	8	5	20	10	4.2	Nov-18
53.1	Hoffman 13 NW irr	Corn Silage 20	7.9	1.8	29	20	38	5	7.4	Oct-19
53.2	Hoffman 13 NE irr	Corn Silage 20	7.8	2.3	45	70	26	5	2.8	Oct-19
53.4	Hoffman 13 SE irr	Wheat 20 irr	7.8	2.2	11	4	27	16	1.4	Oct-19
53.4	Hoffman 13 SW irr	Wheat 20 irr	7.7	1.9	9	3	13	16	1.3	Oct-19




Soil Test Summary

Crop Quest, Inc.
1636 RD Y Tribune KS 67879
<https://www.cropquest.com>

Grower: Ray Smith
Farm: Ray Smith Irrigated
10/10/19

Created by: Johan Marquardt
jmarquardt@cropquest.com
620-214-1623

53.4 Hoffman 13 SW Irr SE Irr S13 16 41														Crop Year: 2019													
Soil Sampling																											
Event Date: 09/28/19																											
Zone/ Sample	Depth in	pH	Buf pH	Ex Lime	Sol Salt mmhos/cm	OM %	NO3 lb/ac	NH4	Tot N	P - M2 ppm	K ppm	SO4 ppm	Zn ppm	Mg ppm	Fe ppm	Mn ppm	Ca ppm	Na ppm	Al	B ppm	Cu ppm	Cl	Mo	CEC meq/100 g			
SW 13/1	0 - 10	7.7		L	1.2	1.9	9.0			13.0	728.0	16.0	1.3	566.0	5.4	1.2	3380.0	54.0		0.6	0.5			23.7	127 ac		
K Base Sat: 8.0% , Ca Base Sat: 71.0% , Mg Base Sat: 20.0% , Na Base Sat: 1.0%																											
1.1	10 - 24						3.0																				
SE 13/2	0 - 10	7.8		N	0.96	2.2	11.0			27.0	843.0	16.0	1.4	459.0	6.1	1.3	3030.0	48.0		0.6	0.5			21.3	118 ac		
K Base Sat: 10.0% , Ca Base Sat: 71.0% , Mg Base Sat: 18.0% , Na Base Sat: 1.0%																											
2.1	10 - 24						4.0																				

5) Photos pertaining to tech farm

a. Section 13 Cover Crop Photos: 4 stages

- 2 Weeks (July)
- 1 Month (August)
- 2 Months (September)
- 4 Months (November)

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87.1 West Wilkens Sprinkler:

- 1) Crop Types: Corn on corn (2018)
- 2) Primary use of that crop:
 - a. The corn was grown for grain.
- 3) Technology/services utilized
 - a. Aerial Imagery (Images below)
 - b. Phytech & AquaSpy moisture probes (Monitoring page below)
 - c. Crop Scout
- 4) Pivot Nozzle Type(s) (if applicable): (Nothing new other than dragon line.)
- 5) Farming Practices this season: No-Till with Herbicides used for weed control. Synthetic fertilizer was used on the corn along with composted manure.
- 6) Cover Crop used? No cover crop used on this pivot this year.
- 7) Yield Data for both West and Middle Wilkens: (Yield map below)

Field #	Field Name	Acres	Total Bushels	Bushels / Acre	Test Weigh	Variety	FarmLogs Rainfall 10/	Planting Date	Previous Crop
87.1	West Wilkens in	96.35	17,245.52	178.99	57.71	209-15 STX B	21.01	27-Apr	Corn

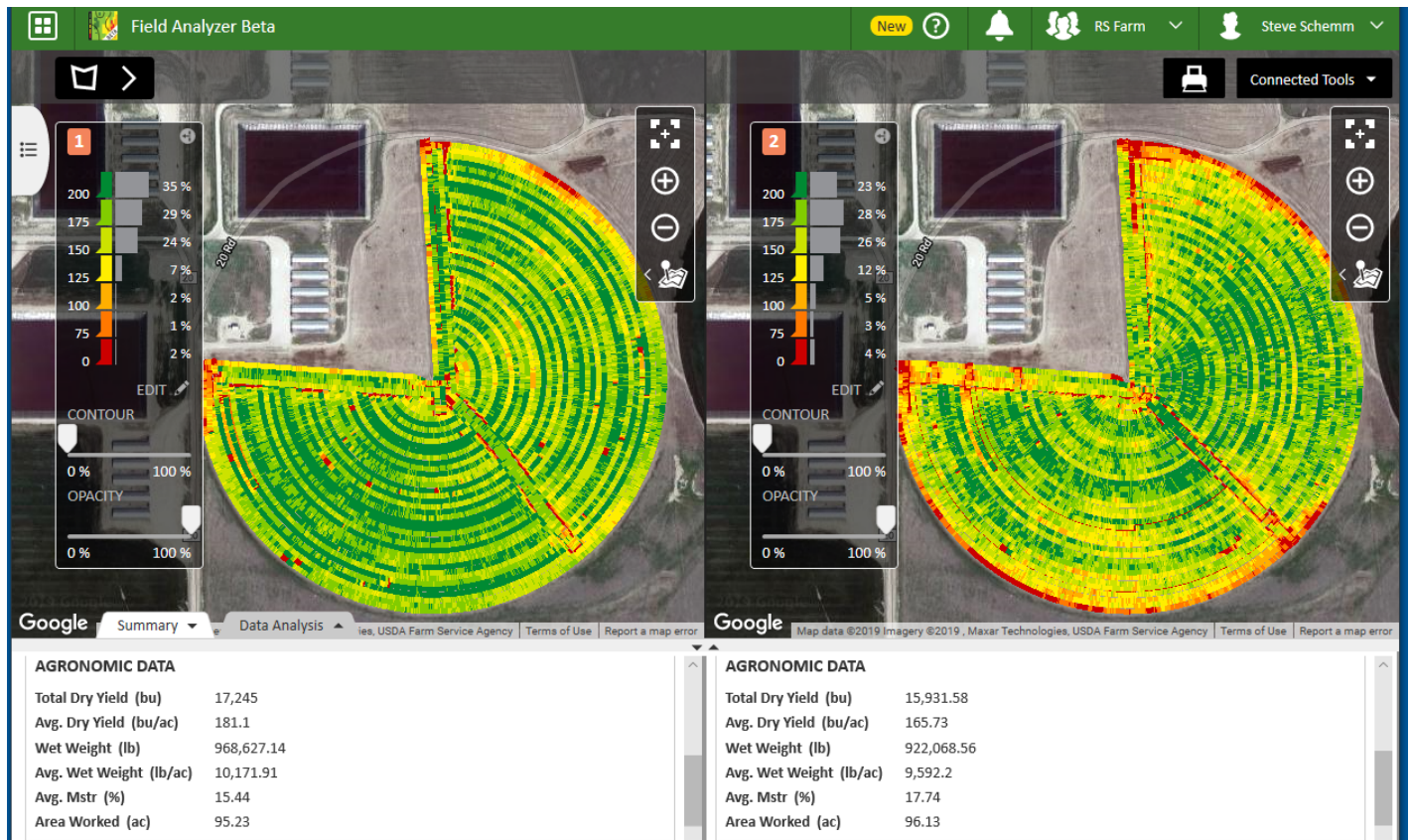
- 8) Water applied for particular Crop:
 - a. 2.08 inches applied on Avg. (Flowmeter/AgSense)
- 9) Water use for entire calendar year:
 - a. 5,438,296 gallons (Flowmeter/AgSense)
- 10) Precipitation data on particular field:
 - a. 21.01 in. YTD / 5.9% wetter than avg.
 - b. 3,681 GDD / 4.6% colder. (FarmLogs)
- 11) Other pertinent information?
 - a. The 2018 crop had early hail damage hurting its yield potential, 2019 did not have hail damage.

Additional Documents to include:

- 1) Combine yield map
87.1 W Wilkens 2019 to 2018 Yield Map Comparison

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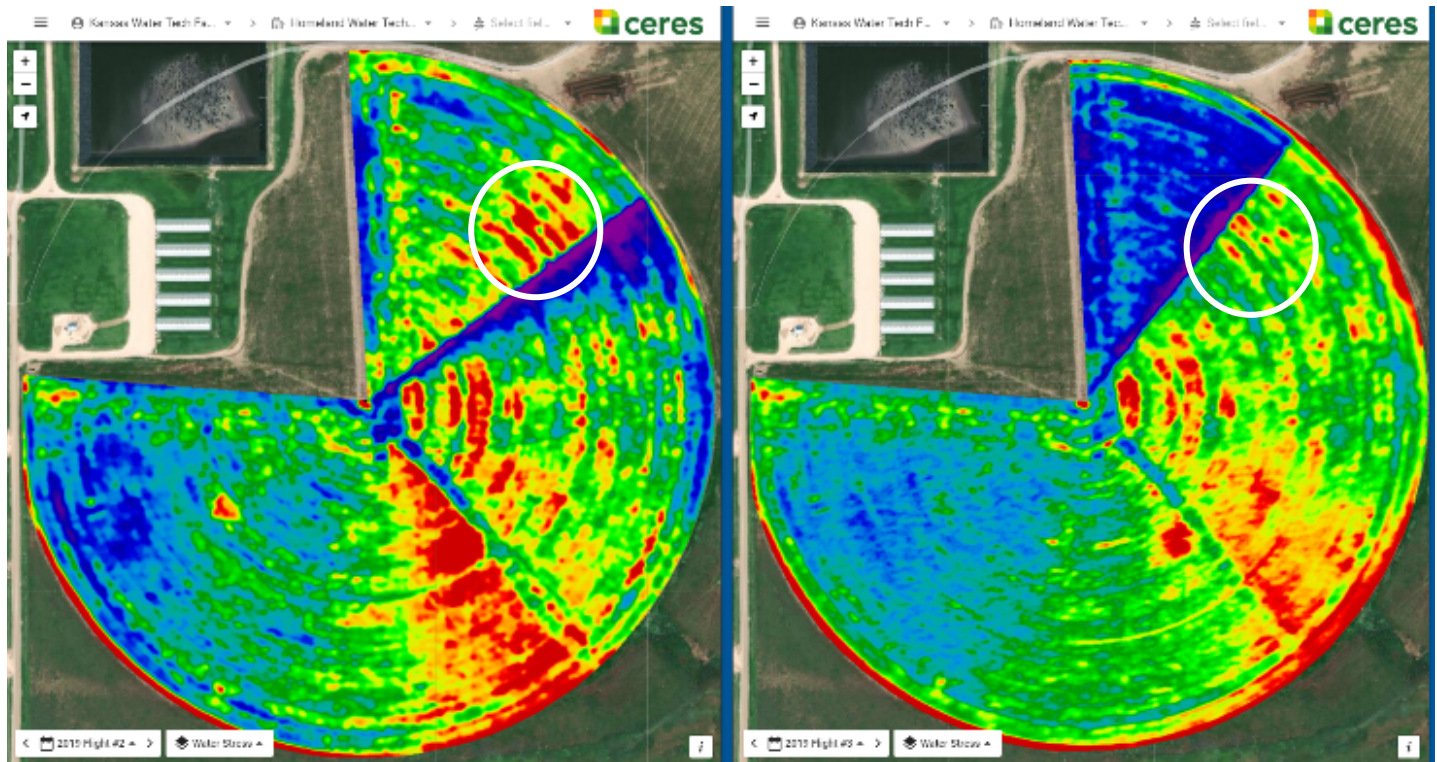
2) Soil test results from agronomist

Field #	Field Name	Crop / Year	PH	Org Material	N 0-10 Inches lbs./Ac	N 10-24 inches lbs./Ac	P	S	Zn	Date
87.1	West Wilkens irr	Corn 19 irr	8	2.3	44	66	58	6	2.2	Nov-18
87.1	West Wilkens irr	Corn 20 Irr	8	2.3	98	140	52	11	2	Dec-19

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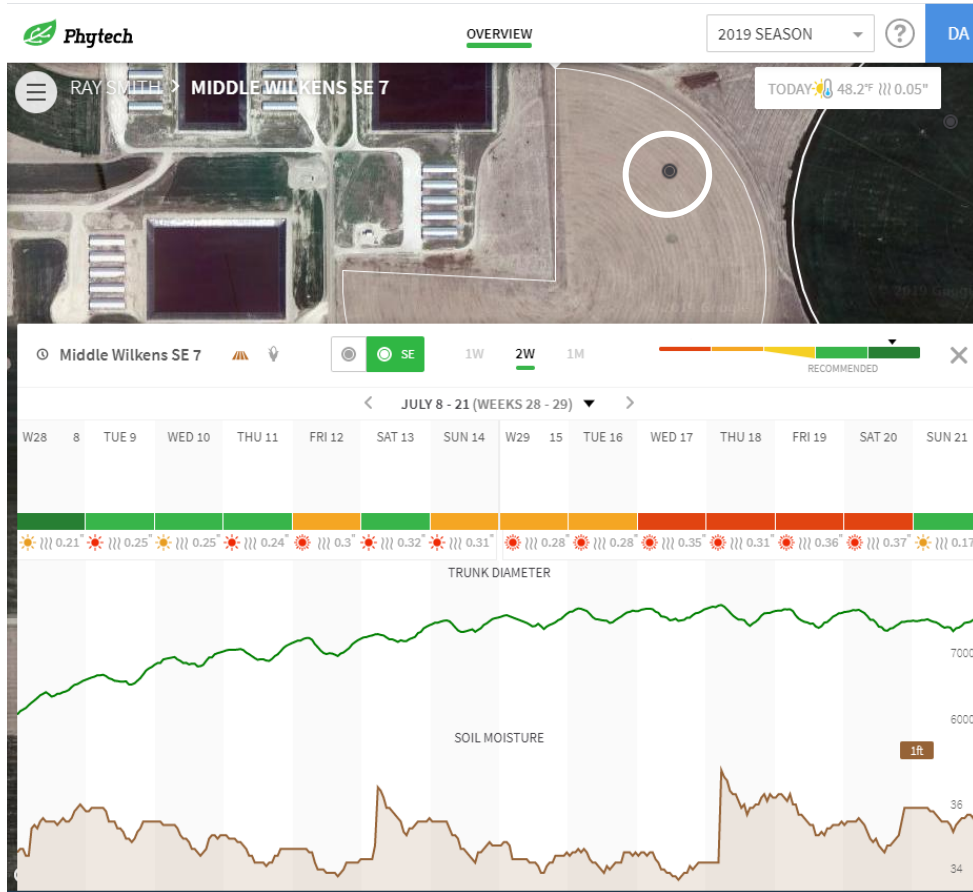
- 3) Ceres Aerial Imagery – These two images show Water Stress on 7/16 & 7/24, and can be correlated with Phytech information regarding plant growth.



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- 4) Soil Probe monitoring profile: Phytech monitoring page for same period in July.



87.2 Middle Wilkens Sprinkler:

- 1) Crop Types: Corn on Corn (2018)
- 2) Primary use of that crop:
 - a. Grain
- 3) Technology or services utilized - Aerial Imagery, Crop Scout, & Phytech moisture probes
- 4) Pivot Nozzle Type(s) (if applicable):
- 5) Farming Practices this season: No-Till with Herbicides used for weed control. No fertilizer was used on the corn other than pig effluent.
- 6) Cover Crop used? None
- 7) Yield Data for Middle Wilkens: (Yield map below)

Field #	Field Name	Acres	Total Bushels	Bushels / Acre	Test Weight	Variety	FarmLogs Rainfall 10/	Planting Date	Previous Crop
87.2	M Wilkens irr	122.99	21,140.26	171.89	58.18	192-10 STX B	21.01	27-Apr	Corn

- 8) Water use/applied for particular Crop:
 - a. 5.72 inches applied on Avg. (Flowmeter & AgSense)
- 9) Water use/applied for entire calendar year:
 - a. 19,113,717 gallons (Flowmeter & AgSense)
- 10) Precipitation data on particular field:
 - a. 21.68 In. YTD / 5.9% wetter than avg.

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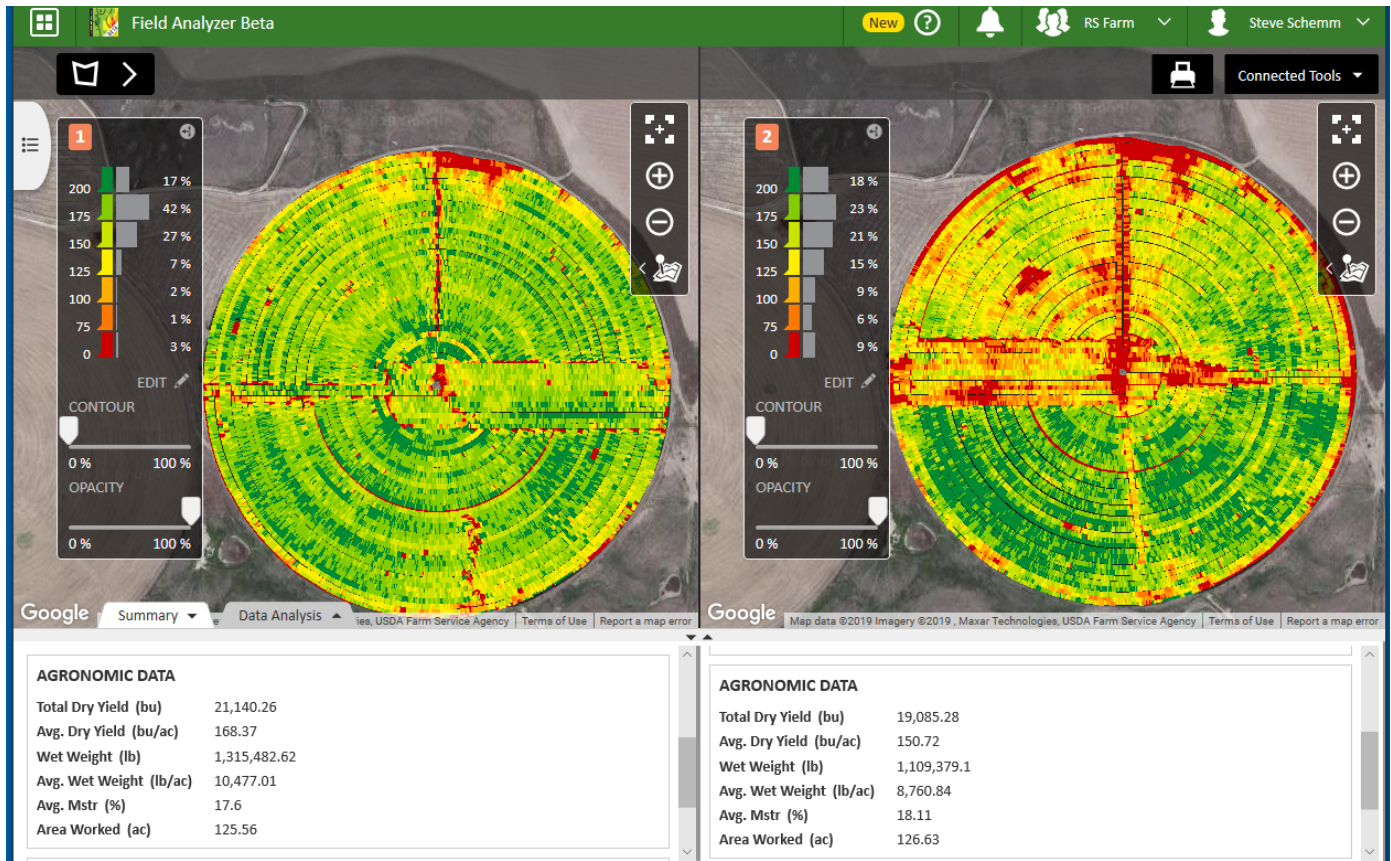
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b. 3,681 GDD / 4.6% colder. (FarmLogs)

11) Other pertinent information? Field sustained some hail damage in 2018.

Additional documents

1) Harvest yield maps comparing 2019 corn to 2018 corn.



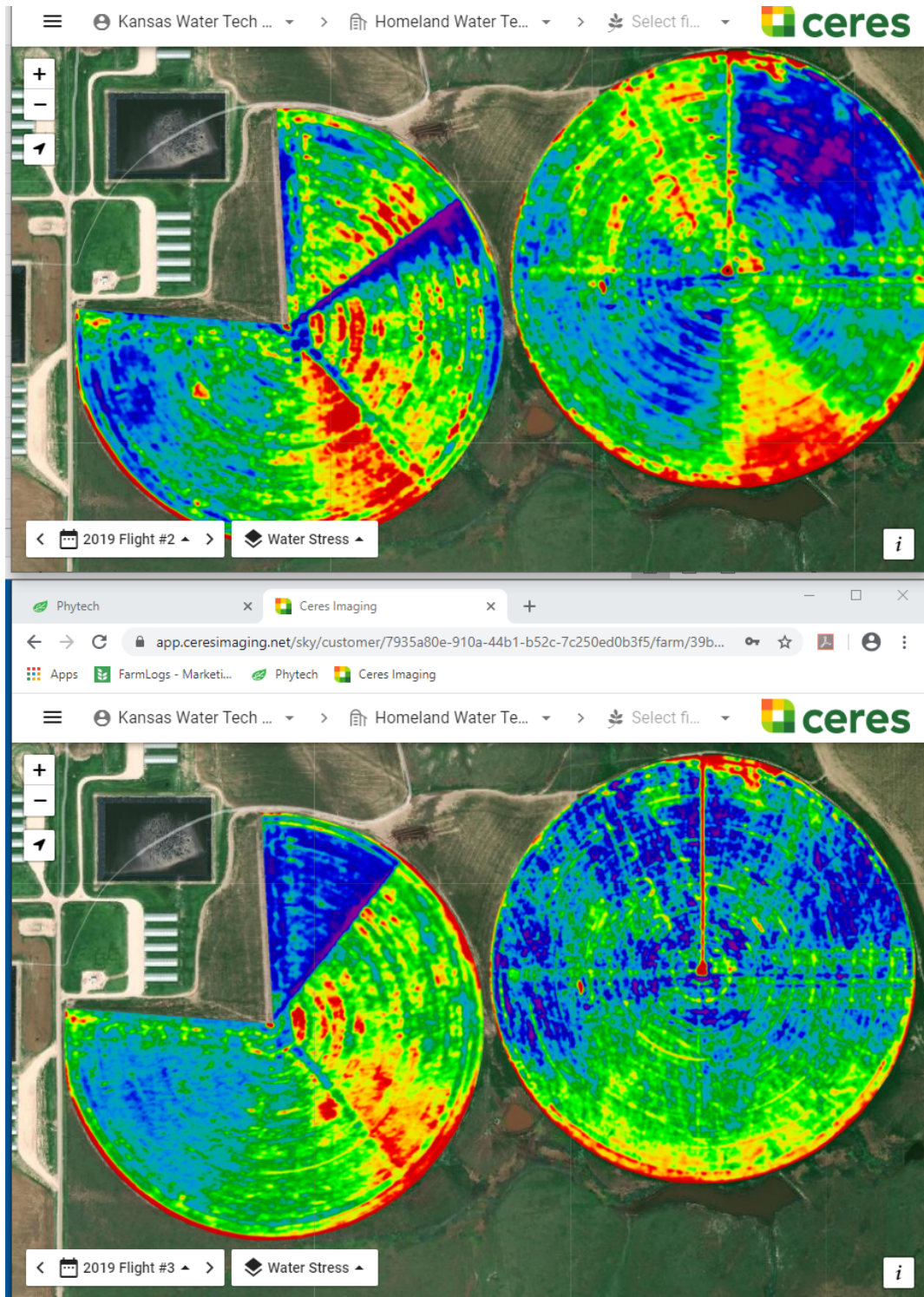
2) Soil test comparisons 2018 and 2019.

Field #	Field Name	Crop / Year	PH	Org Material	N 0-10 Inches lbs./Ac	N 10-24 inches lbs./Ac	P	S	Zn	Date
87.2	M Wilkens irr	Corn 19 irr	8	2.3	33	47	69	6	1.5	Oct-18
87.2	M Wilkens irr	Wheat 20 irr	7.8	2.3	79	116	95	25	2.1	Oct-19

3) Ceres aerial images comparing 7/16 image to 7/24 image for water stress, note the differences in the 2 fields in the 2 different weeks. The west pivot seems much more susceptible to stress because of factors other than water.

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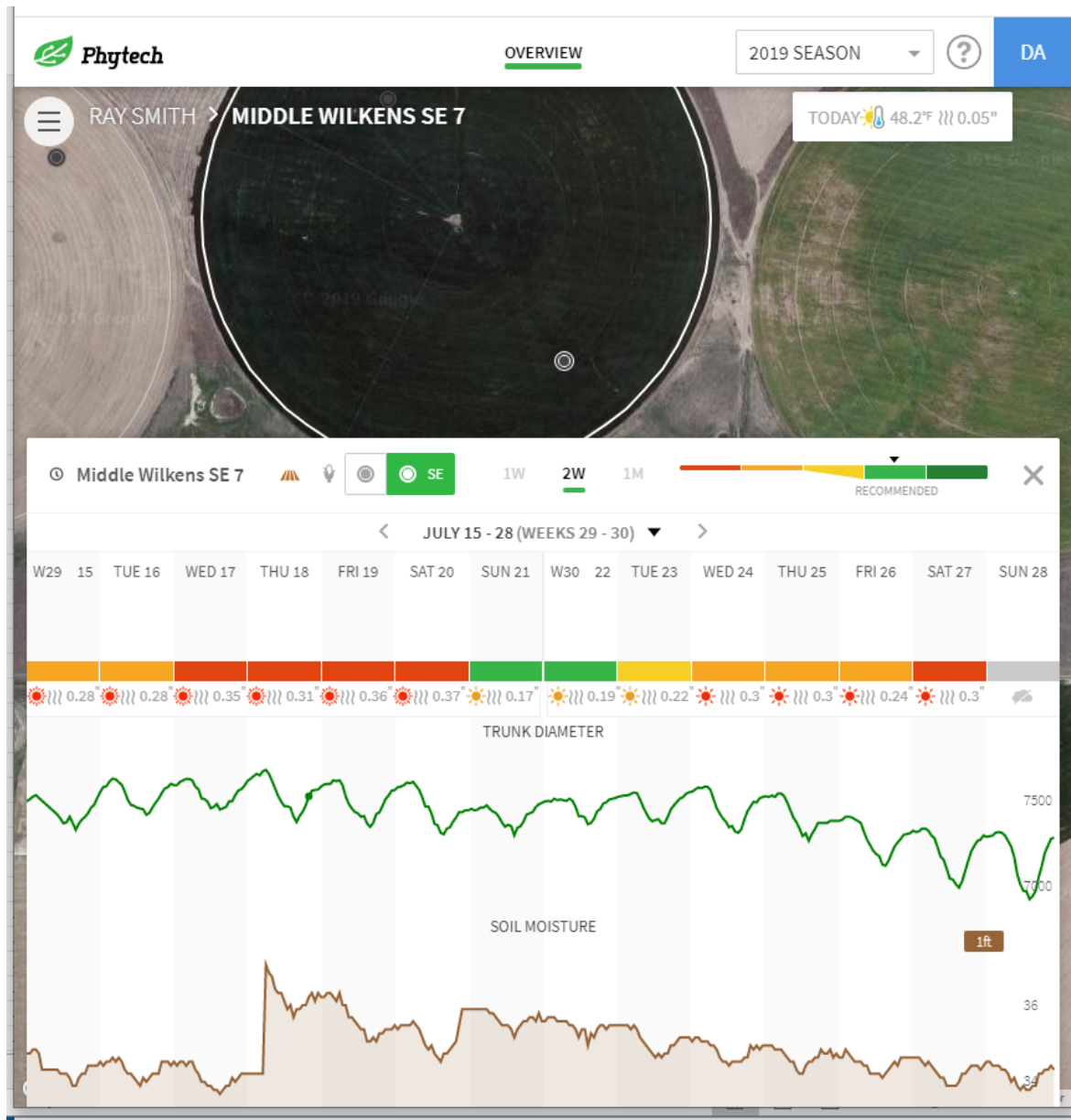


- 4) 87.2 Soil Probe monitoring profile: Phytech monitoring page for 2-week period, shows upcoming forecast also can see predicted or actual high temperature for the day and the amount of evapotranspiration for the day. This can cause Phytech to be red, showing plant stress, even though there is moisture in the soil. Plant growth stage, daily heat (or evapotranspiration), soil moisture, & soil health all effect a plant's stress level along with the abundance of water. Phytech allows us to have

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multiple inputs to monitor what is impacting it. The plant stress in this area at this point in its growth was probably degrading its yield potential to some degree during this time.



88.1 East Wilkens Sprinkler: *(No water tech used other than crop scout because of 1st year in program.)*

- 1) Crop Types: Wheat on Corn (2018)
- 2) Primary use: Grain
- 3) Technology/services utilized
 - a. AquaSpy moisture probe to monitor field after harvest for temperatures & moisture.
 - b. Crop Scout
- 4) Pivot Nozzle Type(s) (if applicable):
- 5) Farming Practices this season: No-Till with Herbicides used for weed control. No synthetic fertilizer or manure was used on the field because pig effluent was applied through the pivot.

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6) Cover Crop used? None

7) Yield/Bushel Data:

Field #	Field Name	Net Bushel	Bushels / Acre	Protein	Test Wt	Variety	Planting Date	Seeded Lb/A	Yld Goa	N/Ac Applie	Nit.	Phos.	Sulf	Zinc	Previous Crop
88.1	East Wilkens irr	12,657.69	102.97	11.65	62.44	Tatanka	9/25/2018	55.0	60	60	147	29	6	1.50	Filw 18

8) Water use/applied for particular Crop:

a. 0.49 inches applied on Avg. (Flowmeter & AgSense)

9) Water use/applied for entire calendar year:

a. 1,623,661 gallons (Flowmeter & AgSense)

10) Precipitation data on particular field:

a. 21.68 In. YTD / 5.9% wetter than avg.

b. 3,681 GDD / 4.6% colder. (FarmLogs)

11) Other pertinent information? Below are the soil tests taken in October 2018 & 2019.

Field #	Field Name	Crop / Year	PH	Org Material	N 0-10 inches lbs./Ac	N 10-24 inches lbs./Ac	P	S	Zn	Date
88.1	East Wilkens irr	Wht 19 irr	7.8	2.1	34	71	29	6	1.5	Oct-18
88.1	East Wilkens irr	Corn 20 Irr	7.7	2.5	49	30	98	7	3.1	Oct-19

Additional documents

1) Harvest yield map for 2019 wheat crop.

